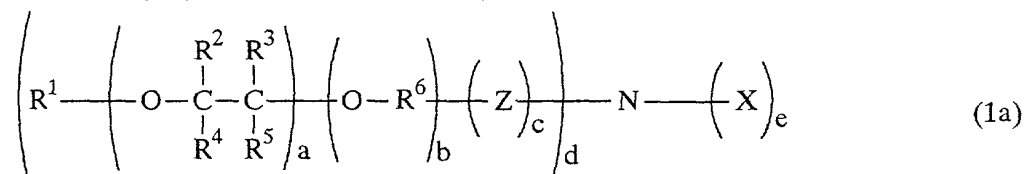


# CLAIMS

What is claimed is :

1. A gasoline additive for a direct injection gasoline engine which comprises at least one nitrogen-containing compound selected from the group consisting of a compound (1A) and a polybutenylamine compound:

said compound (1A) being represented by the formula



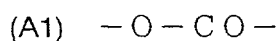
wherein  $R^1$  is selected from the group consisting of a hydrogen and a  $C_1 - C_{30}$  hydrocarbon group,  $R^2$ ,  $R^3$ ,  $R^4$  and  $R^5$  are each independently selected from the group consisting of a hydrogen a  $C_1 - C_{16}$  hydrocarbon group and a group of formula (2a) below,  $a$  is an integer from 1 to 200,  $R^6$  is a  $C_1 - C_{10}$  hydrocarbon group,  $b$  is either 0 or 1,  $Z$  is a group selected from Group A below,  $c$  is either 0 or 1,  $X$  is a group selected from Group B below,  $d$  is an integer from 1 to 3,  $e$  is an integer from 0 to 2 and the sum of  $d$  and  $e$  is equal to 3 ,

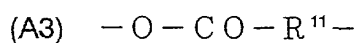
said formula (2a) being



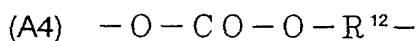
wherein  $R^7$  and  $R^8$  are each independently selected from the group consisting of a hydrogen, a  $C_1 - C_{10}$  hydrocarbon group and a  $C_2 - C_{10}$  alkoxyalkyl group,  $R^9$  is either a  $C_2 - C_6$  alkylene group or a  $C_4 - C_{10}$  alkylene group having an alkoxyalkyl substituent,  $R^{10}$  is hydrogen or a  $C_1 - C_{30}$  hydrocarbon group, and  $f$  is an integer from 0 to 50;

said Group A being constituted by

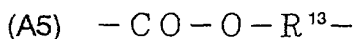




wherein  $\text{R}^{11}$  is a  $\text{C}_1 - \text{C}_6$  alkylene group,



wherein  $\text{R}^{12}$  is a  $\text{C}_1 - \text{C}_6$  alkylene group, and



wherein  $\text{R}^{13}$  is a  $\text{C}_1 - \text{C}_6$  alkylene group,

said Group B being constituted by

(B1) hydrogen,

(B2) a  $\text{C}_1 - \text{C}_{30}$  hydrocarbon group,

(B3) an alkanol group represented by the formula



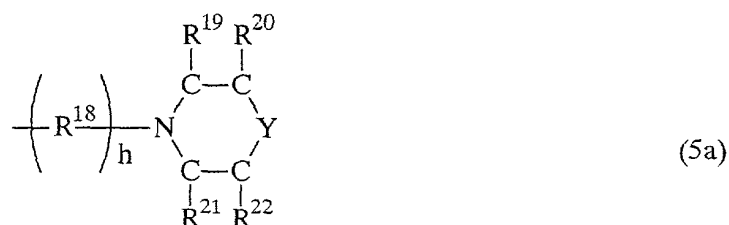
wherein  $\text{R}^{14}$  is a  $\text{C}_1 - \text{C}_6$  alkylene group,

(B4) a nitrogen-containing group represented by the formula



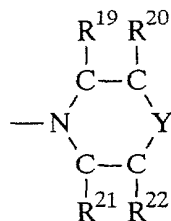
wherein  $\text{R}^{15}$  is a  $\text{C}_2 - \text{C}_6$  alkylene group,  $\text{R}^{16}$  is selected from the group consisting of a hydrogen, a  $\text{C}_1 - \text{C}_4$  alkyl group or a group of formula (3a),  $\text{R}^{17}$  is selected from the group consisting of a hydrogen, a  $\text{C}_1 - \text{C}_{30}$  hydrocarbon group and a group of formula (3a), and  $g$  is an integer from 1 to 5, and

(B5) a group represented by the formula



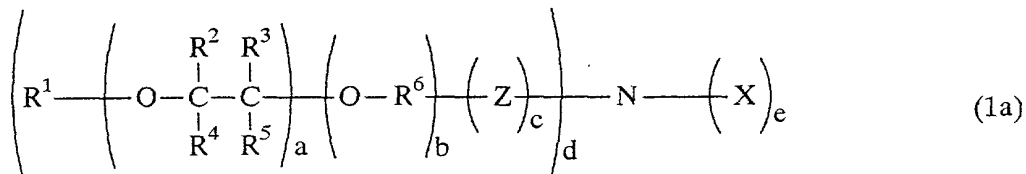
wherein  $R^{18}$  is a  $C_2 - C_6$  alkylene group,  $R^{19}$ ,  $R^{20}$ ,  $R^{21}$  and  $R^{22}$  are each independently selected from the group consisting of a hydrogen, a  $C_1 - C_{10}$  hydrocarbon group and a hydroxyl group, Y is selected from the group consisting of a methylene group, a methylene group substituted by either a  $C_1 - C_{10}$  hydrocarbon group, and a hydroxyl group, an imino group, an imino group substituted by a  $C_1 - C_{10}$  hydrocarbon group or a hydroxyl group, or oxygen, h is equal to 1 if  $e = 1$  and equal to 0 or 1 if  $e = 2$ , with the proviso that the group  $-N-(X)_e$  in formula (1a) is replaced by a group represented by formula (5a') below if  $h = 0$ ;

said formula (5a') being represented by



wherein the N corresponds to the N in formula (1a) and  $R^{19} - R^{22}$  and Y are as defined in formula (5a).

2. The gasoline additive according to claim 1 wherein said component (1A) is represented by the formula

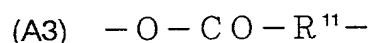
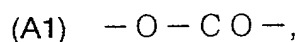


wherein  $R^1$  is selected from the group consisting of a hydrogen, a  $C_1 - C_{12}$  alkyl group, a  $C_6 - C_{18}$  aryl or alkylaryl group,  $R^2$ ,  $R^3$ ,  $R^4$  and  $R^5$  are each independently selected from the group consisting of a hydrogen, a  $C_1 - C_8$  alkyl

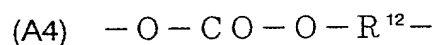
group, and a group of formula (2a), a is an integer from 2 to 200, R<sup>6</sup> is a C<sub>1</sub> – C<sub>6</sub> alkylene group, b is 0 or 1, Z is a group selected from Group A below, c is either 0 or 1, X is a group selected from Group B below, d is either 1 or 2, e is either 1 or 2 and the sum of d and e is equal to 3, said formula (2a) being represented by



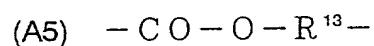
wherein R<sup>7</sup> and R<sup>8</sup> are each independently selected from the group consisting of a hydrogen, a C<sub>1</sub> – C<sub>6</sub> alkyl group, and a C<sub>2</sub> – C<sub>6</sub> alkoxyalkyl group, R<sup>9</sup> is either a C<sub>2</sub> – C<sub>6</sub> alkylene group or a C<sub>2</sub> – C<sub>8</sub> ethylene group having an alkoxyalkyl substituent, R<sup>10</sup> is a C<sub>1</sub> – C<sub>24</sub> alkyl group, and f is an integer from 0 to 30, said Group A being constituted by



wherein R<sup>11</sup> is a C<sub>1</sub> – C<sub>4</sub> alkylene group



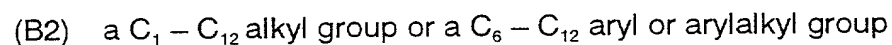
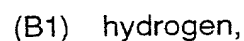
wherein R<sup>12</sup> is a C<sub>1</sub> – C<sub>4</sub> alkylene group,



wherein R<sup>13</sup> is a C<sub>1</sub> – C<sub>4</sub> alkylene group

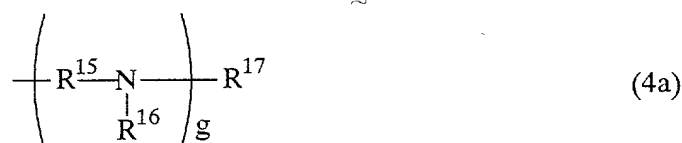
and

said Group B being constituted by



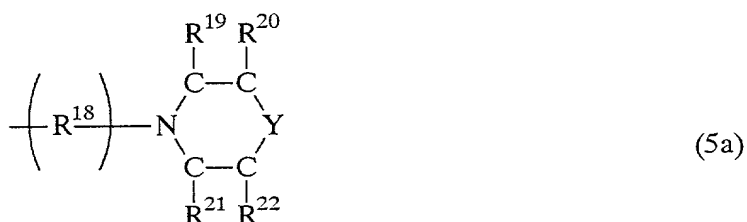
wherein R<sup>14</sup> is a C<sub>1</sub> – C<sub>4</sub> alkylene group,

(B4) a nitrogen-containing group represented by the formula

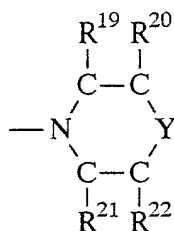


wherein R<sup>15</sup> is a C<sub>2</sub> – C<sub>4</sub> alkylene group, R<sup>16</sup> is selected from the group consisting of a hydrogen, a C<sub>1</sub> – C<sub>3</sub> alkyl group, and a group of formula (3a), R<sup>17</sup> is selected from the group consisting of a hydrogen, a C<sub>1</sub> – C<sub>12</sub> alkyl group, a C<sub>6</sub> – C<sub>12</sub> aryl or arylalkyl group, and a group of formula (3a), and g is an integer from 1 to 4, and

(B5) a group represented by the formula

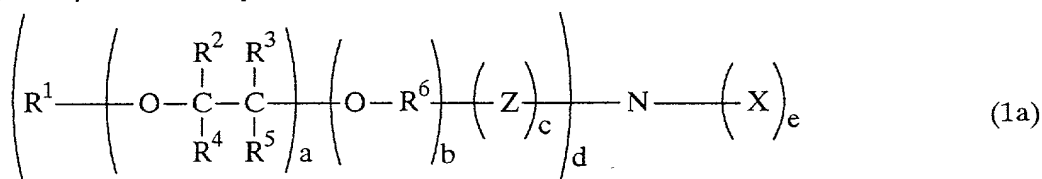


wherein R<sup>18</sup> is a C<sub>2</sub> – C<sub>4</sub> alkylene group, R<sup>19</sup>, R<sup>20</sup>, R<sup>21</sup> and R<sup>22</sup> are each independently selected from the group consisting of hydrogen, a C<sub>1</sub> – C<sub>6</sub> alkyl group, and a hydroxyl group, Y is selected from the group consisting of a methylene group, a methylene group substituted by a C<sub>1</sub> – C<sub>6</sub> alkyl group or a hydroxyl group, an imino group, an imino group substituted by a C<sub>1</sub> – C<sub>6</sub> alkyl group or a hydroxyl group, and oxygen, h is equal to 1 if e = 1 and equal to 0 or 1 if e = 2, with the proviso that the group —N—(X)<sub>e</sub> in formula (1a) is replaced by a group represented by formula (5a') below if h = 0; said formula (5a') being represented by



wherein the N corresponds to the N in formula (1a) and  $R^{19}$  –  $R^{22}$  and Y are as defined in formula (5a).

3. The gasoline additive according to claim 1 wherein said component (1A) is represented by the formula



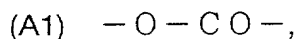
wherein  $R^1$  is selected from the group consisting of a hydrogen or a  $C_1 - C_6$  alkyl group, a phenyl group, and a  $C_7 - C_{15}$  alkylaryl group, and wherein  $R^2$ ,  $R^3$ ,  $R^4$  and  $R^5$  are each independently selected from the group consisting of a hydrogen, a  $C_1 - C_3$  alkyl group and a group of formula (2a) below, a is an integer from 2 to 100,  $R^6$  is a  $C_3 - C_6$  alkylene group, b is either 0 or 1, Z is a group selected from Group A below, c is either 0 or 1, X is a group selected from Group B below, d is 1, e is 2, and

said formula (2a) being represented by



wherein  $R^7$  and  $R^8$  are each independently selected from the group consisting of a hydrogen and a  $C_1 - C_3$  alkyl group,  $R^9$  is a  $C_2 - C_4$  alkylene group,  $R^{10}$  is a  $C_1 - C_{12}$  alkyl group, and f is an integer from 0 to 20,

said Group A being constituted by



(A2)  $-\text{C O}-$ , and

(A4)  $-\text{O}-\text{C O}-\text{O}-\text{R}^{12}-$

wherein  $\text{R}^{12}$  is a  $\text{C}_1 - \text{C}_4$  alkylene group, and

said Group B being constituted by

(B1) hydrogen,

(B3) an alkanol group represented by the formula



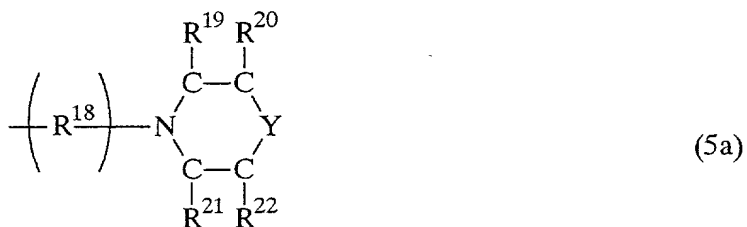
wherein  $\text{R}^{14}$  is a  $\text{C}_1 - \text{C}_3$  alkylene group,

(B4) a nitrogen-containing group represented by the formula



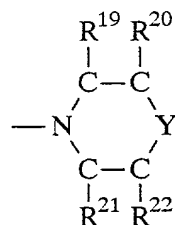
wherein  $\text{R}^{15}$  is a  $\text{C}_2 - \text{C}_3$  alkylene group,  $\text{R}^{16}$  is selected from the group consisting of a hydrogen, a methyl group, an ethyl group, and a group of formula (3a),  $\text{R}^{17}$  is selected from the group consisting of a hydrogen, a  $\text{C}_1 - \text{C}_6$  alkyl group, a phenyl group, a  $\text{C}_7 - \text{C}_9$  arylalkyl group and a group of formula (3a), and  $g$  is an integer from 1 to 3, and

(B5) a group represented by the formula



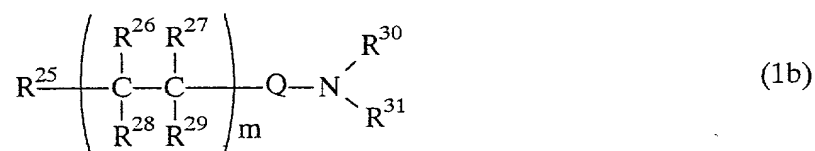
wherein  $\text{R}^{18}$  is a  $\text{C}_2 - \text{C}_3$  alkylene group,  $\text{R}^{19}$ ,  $\text{R}^{20}$ ,  $\text{R}^{21}$  and  $\text{R}^{22}$  are each independently selected from the group consisting of a hydrogen, a  $\text{C}_1 - \text{C}_3$  alkyl group and a hydroxyl group,  $\text{Y}$  is selected from the group consisting of an imino group, an imino

group substituted by a  $C_1 - C_3$  alkyl group or a hydroxyl group and oxygen, h is equal to 0 or 1, with the proviso that with the group  $-N-(X)_e$  in formula (1a) is replaced by a group represented by formula (5a') below if  $h = 0$ ;  
said formula (5a') being represented by



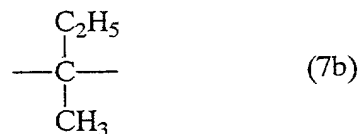
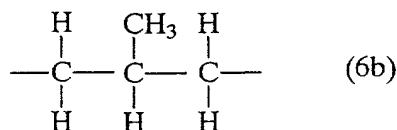
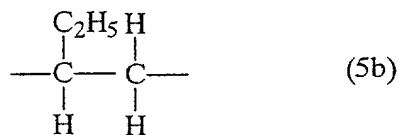
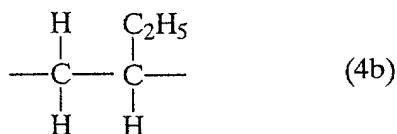
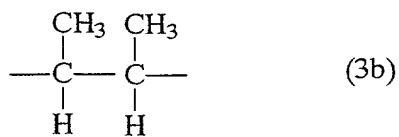
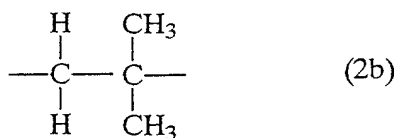
wherein the N corresponds to the N in formula (1a) and  $R^{19} - R^{22}$  and Y are as defined in formula (5a).

4. The gasoline additive according to claim 1 wherein said polybutenylamine compound is a compound (1B) represented by the formula

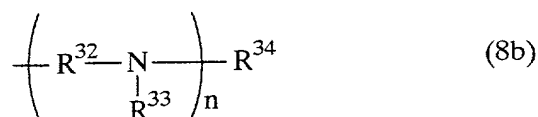


wherein  $R^{25}$  is selected from the group consisting of an n-butyl group, a sec-butyl group, and a tert-butyl group,  $R^{26}$ ,  $R^{27}$ ,  $R^{28}$  and  $R^{29}$  are each independently a hydrogen, a methyl group and an ethyl group, and the total carbon number of  $R^{26}$ ,  $R^{27}$ ,  $R^{28}$  and  $R^{29}$  groups is 2, Q is a group represented by one of formulae (2b) to (7b) below,  $R^{30}$  and  $R^{31}$  are each independently selected from the group consisting of a hydrogen, a  $C_1 - C_{10}$  hydrocarbon group, a  $C_1 - C_8$  alkanol group, and a group represented by formula (8b) below, and m is an integer from 1 to 100,  
said formulae (2b) to (7b) being represented by



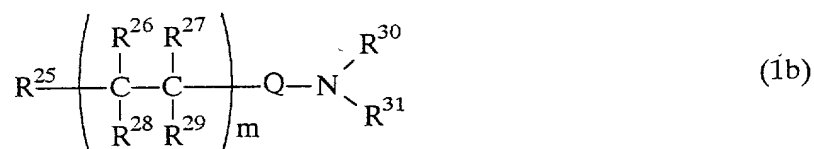


said formula (8b) being represented by



wherein  $\text{R}^{32}$  is a  $\text{C}_1 - \text{C}_4$  alkylene group,  $\text{R}^{33}$  is either a hydrogen or a  $\text{C}_1 - \text{C}_4$  alkyl group,  $\text{R}^{34}$  is either a hydrogen or a  $\text{C}_1 - \text{C}_{10}$  hydrocarbon group, and  $n$  is an integer from 1 to 5.

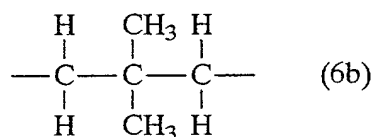
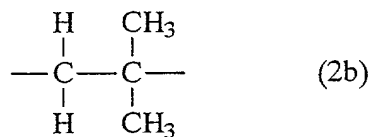
5. The gasoline additive according to claim 4 wherein said compound (1B) is represented by the formula



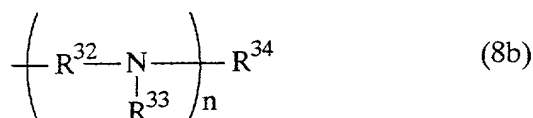
wherein either (i)  $\text{R}^{25}$  is a tert-butyl group,  $\text{R}^{26}$  and  $\text{R}^{28}$  are each hydrogen and  $\text{R}^{27}$  and  $\text{R}^{29}$  are each a methyl group, or (ii)  $\text{R}^{25}$  is a tert-butyl group,  $\text{R}^{26}$  and  $\text{R}^{28}$  are each a methyl group and  $\text{R}^{27}$  and  $\text{R}^{29}$  are each hydrogen, Q is a group represented by formula (2b) or (6b) below,  $\text{R}^{30}$  and  $\text{R}^{31}$  are each independently selected from the group consisting of a hydrogen, a  $\text{C}_1 - \text{C}_{10}$  alkyl group, a  $\text{C}_2 - \text{C}_{10}$  alkenyl group, a  $\text{C}_5 - \text{C}_{10}$  cycloalkyl or alkylcycloalkyl group, a  $\text{C}_6 - \text{C}_{10}$  aryl or

alkylaryl group, a C<sub>7</sub> – C<sub>10</sub> arylalkyl group, a C<sub>1</sub> – C<sub>8</sub> alkanol group, and a group represented by formula (8b) below, and m is an integer from 5 to 50,

said formulae (2b) and (6b) being represented by

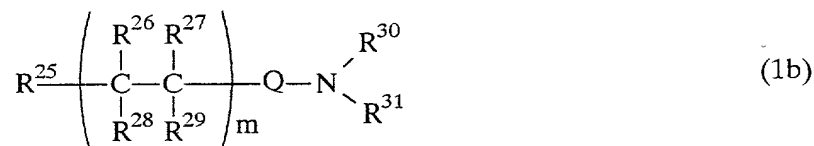


said formula (8b) being represented by

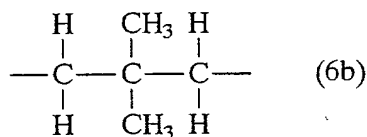


wherein R<sup>32</sup> is a C<sub>1</sub> – C<sub>3</sub> alkylene group, R<sup>33</sup> is either hydrogen or a C<sub>1</sub> – C<sub>3</sub> alkyl group, R<sup>34</sup> is either hydrogen or a C<sub>1</sub> – C<sub>3</sub> alkyl group, and n is an integer from 1 to 3.

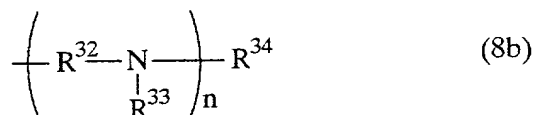
6. The gasoline additive according to claim 4 wherein said compound (1B) is represented by the formula



wherein either (i) R<sup>25</sup> is tert-butyl group, R<sup>26</sup> and R<sup>28</sup> are each hydrogen and R<sup>27</sup> and R<sup>29</sup> are each methyl group or (ii) R<sup>25</sup> is tert-butyl group, R<sup>26</sup> and R<sup>28</sup> are each methyl group and R<sup>27</sup> and R<sup>29</sup> are each a hydrogen atom, Q is a group represented by formula (6b), R<sup>30</sup> and R<sup>31</sup> are each independently selected from the group consisting of a hydrogen, a C<sub>1</sub> – C<sub>10</sub> alkyl group, a C<sub>2</sub> – C<sub>10</sub> alkenyl group, a C<sub>5</sub> – C<sub>10</sub> cycloalkyl or alkylcycloalkyl group, a C<sub>6</sub> – C<sub>10</sub> aryl or alkylaryl group, a C<sub>7</sub> – C<sub>10</sub> arylalkyl group, a C<sub>1</sub> – C<sub>4</sub> alkanol group, and a group represented by formula (8b) below and m is an integer from 10 to 40, said formulae (6b) being represented by



said formula (8b) being represented by



wherein  $\text{R}^{32}$  is a  $\text{C}_1 - \text{C}_3$  alkylene group,  $\text{R}^{33}$  and  $\text{R}^{34}$  is each a hydrogen, and  $n$  is an integer of 1.

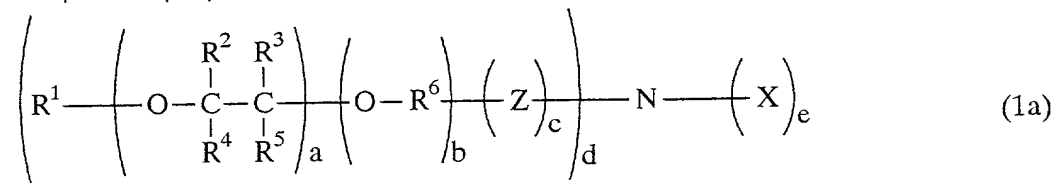
7. The gasoline additive according to claim 4 wherein the number-average molecular weight of said compound (1B) is within the range of 200 to 6,000.

8. The gasoline additive according to claim 4 wherein the number-average molecular weight of said compound (1B) is within the range of 400 to 3,000.

9. The gasoline additive according to claim 4 wherein the number-average molecular weight of said compound (1B) is within the range of 700 to 2,400.

10. A gasoline composition for use in a direct injection gasoline engine, which composition comprises a base gasoline and at least one nitrogen-containing compound selected from the group consisting of compound (1A) and a polybutenylamine compound:

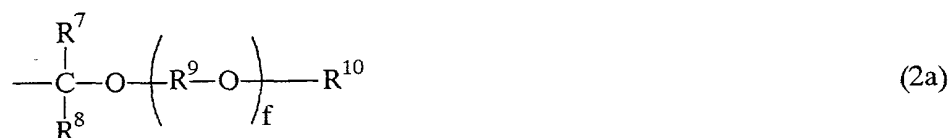
said compound (1A) being represented by the formula



wherein  $\text{R}^1$  is either a hydrogen or a  $\text{C}_1 - \text{C}_{30}$  hydrocarbon group,  $\text{R}^2$ ,  $\text{R}^3$ ,  $\text{R}^4$  and

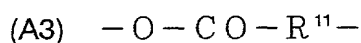
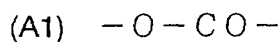
$R^5$  are each independently selected from the group consisting of a hydrogen, a  $C_1 - C_{16}$  hydrocarbon group, and a group of formula (2a) below, a is an integer from 1 to 200,  $R^6$  is a  $C_1 - C_{10}$  hydrocarbon group, b is either 0 or 1, Z is a group selected from Group A below, c is either 0 or 1, X is a group selected from Group B below, d is an integer from 1 to 3, e is an integer from 0 to 2, and the sum of d and e is equal to 3,

said formula (2a) being

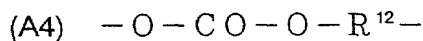


wherein  $R^7$  and  $R^8$  are each independently selected from the group consisting of a hydrogen, a  $C_1 - C_{10}$  hydrocarbon group and a  $C_2 - C_{10}$  alkoxyalkyl group,  $R^9$  is either a  $C_2 - C_6$  alkylene group or a  $C_4 - C_{10}$  alkylene group having an alkoxyalkyl substituent,  $R^{10}$  is a  $C_1 - C_{30}$  hydrocarbon group, and f is an integer from 0 to 50,

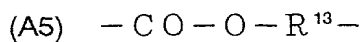
said Group A being constituted by



wherein  $R^{11}$  is a  $C_1 - C_6$  alkylene group,



wherein  $R^{12}$  is a  $C_1 - C_6$  alkylene group, and



wherein  $R^{13}$  is a  $C_1 - C_6$  alkylene group,

said Group B being constituted by

(B1) hydrogen,

(B2) a  $C_1 - C_{30}$  hydrocarbon group,

(B3) an alkanol group represented by the formula



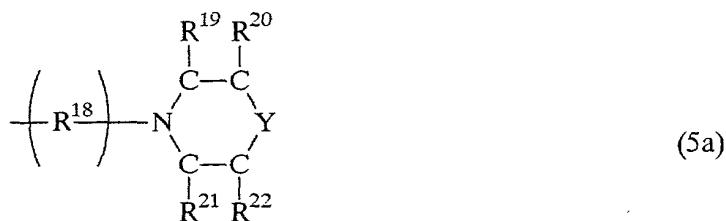
wherein  $R^{14}$  is a  $C_1 - C_6$  alkylene group,

(B4) a nitrogen-containing group represented by the formula



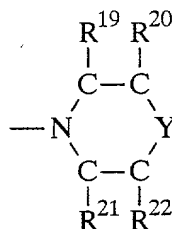
wherein  $R^{15}$  is a  $C_2 - C_6$  alkylene group,  $R^{16}$  is selected from the group consisting of a hydrogen, a  $C_1 - C_4$  alkyl group and a group of formula (3a),  $R^{17}$  is selected from the group consisting of a hydrogen, a  $C_1 - C_{30}$  hydrocarbon group, and a group of formula (3a), and  $g$  is an integer of between 1 and 5, and

(B5) a group represented by the formula



wherein  $R^{18}$  is a  $C_2 - C_6$  alkylene group,  $R^{19}$ ,  $R^{20}$ ,  $R^{21}$  and  $R^{22}$  are each independently selected from the group consisting of a hydrogen, a  $C_1 - C_{10}$  hydrocarbon group, and a hydroxyl group,  $Y$  is selected from the group consisting of a methylene group, a methylene group substituted by a  $C_1 - C_{10}$  hydrocarbon group or a hydroxyl group, an imino group, an imino group substituted by a  $C_1 - C_{10}$  hydrocarbon group or a hydroxyl group, and oxygen,  $h$  is equal to 1 if  $e = 1$  and equal to 0 or 1 if  $e = 2$ , with the proviso that the group  $-N-(X)_e$  in formula (1a) is replaced by a group represented by formula (5a') below if  $h = 0$ ;

said formula (5a') being represented by



wherein the N corresponds to the N in formula (1a) and  $\text{R}^{19}$  –  $\text{R}^{22}$  and Y are as defined in formula (5a).

11. The gasoline composition according to claim 10 wherein said compound (1A) is contained in an amount of 0.001 to 10 mass percent, based on the total composition.

12. The gasoline composition according to claim 10 wherein said polybutenylamine compound is contained in an amount of 0.001 to 10 mass percent, based on the total composition.